N.A.C.A. BULLETIN

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EDITORIAL DEPARTMENT NOTE

Production control and production planning are universal goals wherever vendors' deliveries, raw material inventories, manufacturing processes, finished goods storage, and sales form so long a chain that kinks and snags develop if the sequence of events is not closely watched. This doubtless describes the situation of a majority of industrial companies today. Our first article, based on a company with a single principal product but with twelve manufacturing plants, sets forth a unique planning and control procedure, an outstanding feature of which is control of the mix of item size and type in production through use of ratio data tied to the company's sales forecast.

This article was written by C. E. CARLSON, a previous contributor to the *Bulletin*, who is Assistant Treasurer of the National Battery Company, St. Paul, Minn. The methods described are in force in the author's company, with which he has been connected through its period of growth.

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The interest in incentives remains on a high level largely because of the appeal which well-devised plans make to those who are seeking a means to increase productivity in ways which recognize all participants in the process. Recent issues of the *Bulletin* have carried a number of articles on over-all incentives sometimes favored as tending toward simplicity in application. The second article in the present issue presents a plan for individual incentives for direct workers which also is drawn up to avoid complications in use.

The author, JOHN J. BARRANGER, is Assistant Secretary of Bendix Aviation Corp., and as Chief Factory Accountant and Divisional Auditor of Bendix Radio Division of that company at Baltimore, Md., has developed and installed the accounting procedures in effect there. He was formerly associated with the May Oil Burner Co., General Aviation Manufacturing Corp., and other companies in Baltimore.

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"Lifo" basis of inventory valuation, subsequent to its permissive use for federal income tax purposes in 1939, has attracted companies in many lines as a way of matching income with applicable costs in a period of changing price levels. In some instances, a principal inducement to its adoption may have been the opportunity to reduce income tax liability while costs continued to rise. The method has, however, unexpected effects as applied to particular industries and particular companies. Some of these are outlined in our final article which analyzes the results of valuing cotton mill inventories on the "lifo" basis.

The subject is presented by E. G. FIELD, an engineer, who has given a major portion of his attention to the problems of cotton textile mills over a considerable period. Prior to this, Mr. Field had diversified experience with a number of industrial and consulting firms after an early apprenticeship under the late H. L. Gantt.

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DECEMBER 1, 1947

PRODUCTION CONTROL FOR MAINTENANCE OF BALANCED STOCKS

by C. E. CARLSON

Assistant Treasurer, National Battery Co.,
St. Paul, Minn.

IT IS IMPORTANT in most industries to keep production and sales running along together but the need to keep finished goods inventories in shape to meet customer requirements without building up excess stocks of any item at any point is particularly pressing in a company making a perishable product. As anyone who has left a wet storage battery idle in a corner of the basement knows, automobile storage batteries, which occupy the facilities of nine of our plants located in the large centers of car population throughout the country, are an electrochemical product of limited life. Likewise, the automotive industry with which it is so intimately connected imposes new design requirements from time to time and research and engineering activities within the battery industry bring about changes in construction intended to lengthen the life of the product and increase its efficiency. These conditions help to make effective production control a "must."

In considering our system of production control, which contains so strong an element of planning that control takes the form of a consequence rather than a procedure, the structure of the company must be borne in mind. Although manufacturing is completely decentralized, management is almost as completely centralized in our home office. Hence planning originates there, is supplemented at the factories within the scope of the plans, and results are, of course, read and appraised in reports from the plants disclosing their situation as to materials, goods in process, inventories, and customers' orders. A broad question of adequate communication and coordination is also presented.

Model Inventory Position

We work for a model inventory for the company and for each location. In this, size of inventory, although important, is secondary to make-up. A model inventory position, to us, is one in which quantities of finished product on hand by (1) customer brands and (2) grades and types—our two principal groupings—

are so balanced that orders can be filled without waiting for additional production. Total inventory may vary somewhat for seasonal, sales, production, or policy reasons but if inventory and oncoming production are balanced on a firm basis, adjustments are easily made.

That is why the percentage relationship of items, over-all and by plants, in inventory and governing production, means the most to us and why we plan our production in terms of maintaining a stock showing these percentages in its composition. There is also a special reason, which we feel follows the logic of the case, for applying these mix percentages to the desired inventory position. In doing so, we automatically adjust production for any unbalance that has crept into opening inventory through the miscalculations to which the best of planning is subject. Our procedure involves analyzing, through the developed percentage relationships of customer brands and, further, of grades and types, the stock requirements for the period of the estimate. We then deduct the opening inventory, similarly analyzed to arrive at the forecast composition of production. Naturally, even though we keep inventory balance constantly in sight in this way, our model make-up of stock is never exactly achieved but we are always building toward it and never away from it.

Basis in Sales Estimates

Before we can apply our principle we must have the figures for what we are likely to be able to sell for the period which the planning covers. Sales forecasts are developed from information from several sources, including sales department estimates, estimates from large customers who sell to the wholesale or retail trade, car registrations, trade association statistics, and analyses of prior period sales by territories. In using this information the greatest weight is given to our own prior period sales. Sales for a period of several months are used in order to level short-term trends. It is also necessary to use a period long enough to provide perspective as we sell to wholesalers and large merchandisers whose inventory policies may have some effect on the sales picture. Battery sales volume also varies considerably by seasons and it is necessary to take this factor into consideration.

While the total volume of business can be forecast fairly easily as well as accurately, it is more difficult to forecast the pattern it

will follow as to types and grades of product. Here we have to rely principally on the past but allow for trends. We plan our production on the assumption that sales by types and grades of product will follow a normal pattern indicated by experience. Our plan is set up in such a way that it takes into account and adjusts for subnormal and abnormal fluctuations.

The process of using these estimates to determine the production necessary to maintain inventories in conformity with the plan is carried out at the home office to the point of providing each plant with percentages representing the proportion of its production to be devoted to each customer brand or trade brand. The further percentage analysis to type and grade of product is performed at each plant. A definite production rate is assigned to the factory. It is apparent, then, that—so long as the percentages hold, and they are based as firmly as we have facts to support them—a simple change in the production rate is a rational answer to changes in sales volume in most instances.

Purchasing Geared to Planned Production

The foregoing procedures provide a detailed and yet flexible forecast showing what we must go ahead and make to keep our inventories abreast but not ahead of sales. Each of the nine plants is in a position to, and does, schedule its production, but there is one more important aspect of planning to be worked into our procedures if there are not to be snags and delays. We must balance purchases as to time, items, and quantity if we are to balance inventories from the bottom up and keep production and sales in the planned equilibrium. We must work backward from the production forecast to the materials needed and see that they get to each plant on time.

The basic records kept at the plant are perpetual inventories of parts and finished product, reports of orders holding, and the record of anticipated production derived from the percentages on which our whole scheme of balance is predicated. Each factory, having set up its schedule of production for a definite period, forwards a copy together with an inventory position report to the home office which places orders for all major items of material. It is the job of the home office to determine the material requirements of plants from the information submitted and to schedule the shipments so that they will arrive in ample time to service the planned production.

In a system in which the home office projects future requirements, sometimes for a longer period than that for which production has been scheduled by the plants, a great deal of coordination is necessary. There is the problem of cut-off for reporting purposes and of timing in getting the reports to the home office. For example, inventory position reports must include definite information on receipts of materials from suppliers so that the home office can take these into account in making the projection of future needs. There is also the problem of coordinating planning and purchasing within the home office. Our purchasing department performs the function of developing sources of supply, negotiating prices and terms, and arranging for over-all contractual commitments. Samples of materials are submitted to the engineering department for approval as to dimensions, quality, and proper design. After the engineering and purchasing departments have approved the sources of supply, the function of scheduling of material as to types, kind, and quantity is handled by the production planning department. Detailed information is prepared by the last-named department and submitted to the purchasing department, where the orders are written and forwarded to suppliers.

It may help understanding of our particular situation if a brief outline is given of the types of materials necessary to our product. There are three general classifications, as follows:

1. Raw materials purchased in bulk for conversion to parts at each manufacturing plant.
2. Purchased parts common to many types of the finished product.
3. Purchased parts applicable to a specific finished product.

Raw Material Requirements

It is apparent that the first item, raw material, presents no real forecasting problem if available from vendors in needed quantities. Once the production schedule for each plant is determined and the inventory policy is established, the requirements can be computed and orders placed. Periodic inventories and simple records of consumption by plants supply the necessary information, through the inventory position report, to handle this part of the work. Nevertheless, the best production plans can be upset by delays in ordering or receiving materials from suppliers or by ordering insufficient quantities of certain types of material. The function of scheduling shipments from suppliers is interrelated

with our planning work and is a part of the duties of the production planning department.

Each factory maintains perpetual inventory records of all major items of materials. These records form the basis for developing the information for the orders which we place with suppliers from the home office. The inventory position report contains data as to inventory on hand by kinds of raw material, together with an approximate inventory of the raw material in manufactured parts on hand, and this is sufficient information to determine the quantity of materials to be ordered. In determining raw materials in parts on hand, the total quantity is first determined and then the quantity of each kind of raw material can be arrived at by the use of information on consumption in manufacture. Usually orders for material of this kind are handled on a monthly basis, each factory being given a copy of the purchase order with instructions to advise the supplier directly of any changes in the shipping schedule.

Purchased Parts

Here we strike a more complicated problem because the integration of purchasing and production must be more closely maintained. Purchased parts common to many types of the finished product present more of a problem than raw materials because the determination of quantities to be ordered must be more exact as to sizes and in many instances it is necessary to give suppliers long-term production schedules so that they can build and carry inventories available for shipment upon receipt of orders from us. For purchased parts which can only be used in a specific finished product, the foregoing factors are even more pronounced, and constitute perhaps our major production problem. Poor planning in the handling of items of this kind may result in inability to supply a customer's requirements or may cause losses due to obsolescent inventories. This part of our production control is further complicated by changes in customer lines which usually involve changes in equipment at suppliers' plants. Changes in design or lines must be and usually are anticipated a considerable time in advance of placing the lines in production in our factories.

Holding the Balance

As in the case of raw materials, the home office uses as basic data the plant production schedules and inventory position reports

furnished by each factory. This gives the net stock position after taking into consideration the finished product inventory, the purchased parts that are directly applicable to specific types of the finished inventory, the orders holding, and the production already planned by the factory. To this position the home office must add the material in transit and orders already sent to suppliers on which shipping notices have not been received. The totals arrived at for each type of part are then subtracted from the related model inventory position to determine the quantities to be ordered.

We project our requirements on a basis of successive weekly cycles for the purpose of ordering materials. We have previously determined the model inventory for each factory and we know what the weekly rate of production will be in each case. Hence, regardless of whether we are placing orders for a week which is six, seven, or eight weeks ahead, we can place them with the assurance that they are going to be substantially right as to quantities by types. It may be noted again that in planning toward a model inventory position we provide material for production on a basis which works toward restoring balance in inventories if operating conditions or temporary sales fluctuations have tended to throw it out. Permanent sales mix fluctuations are really taken care of too, for they will ultimately affect the data on which we base our model percentages.

These purchasing methods apply particularly to parts that pertain only to a specific finished product. Where parts are common to a large number of types of finished product some of the steps in the procedure are eliminated. Thus for parts of the latter kind we start with the factory inventory to which we add materials in transit and on order and arrive at the total to be subtracted from the model position to determine the quantities, by sizes, for which related orders will be placed. The more common an item, the larger inventory can safely be carried at each factory as there is less possibility that this type of material will place an element of unbalance in the inventory.

In ordering materials there are other factors that must be given consideration. One of them is to request suppliers to ship on definite dates so that materials will arrive at factories on an orderly basis to avoid bunching and thereby complicate the receiving and unloading job.

Procedure at the Plants

We have outlined the development of basic percentages supplied to the factories so that their production will be distributed in proper proportions among customer or trade brands and have stated that each factory refines these percentages to type and size within the larger categories. We have also noted that each factory is furnished with an over-all production rate based on total sales expectation and that, with these two tools, it is in a position to set its own production schedule. We have traced this schedule, accompanied by an inventory position report, back to the home office where purchases of raw materials and parts are made in accordance with the governing principle, so that the schedules can be met. A brief comment as to the more technical side of production scheduling at the plants may help to round out the picture.

Once the quantities and types of production have been determined for a given period, production is arranged in a manner directed toward getting the best use of production facilities and the available materials. The work is laid out in a pattern that will reduce the number of setup changes and will minimize interruptions in the flow of materials. This part of the production scheduling work is related entirely to the assembling process, since the operations which precede assembly can be planned by an over-all breakdown of product requirements.

Special Situations

In the foregoing discussion we have covered the normal production control procedure handled largely on a routine basis. Now we approach the question of what to do with unusual situations, such as a sharp short-term trend that may threaten to exhaust the inventory of certain types or the introduction of new lines or the handling of changes in design. Since our normal production and ordering has already been scheduled, we plan to take care of these developments as exceptions. By that I mean that we will superimpose additional ordering on our regular program. Suppliers will be requested to include in cars that are ready to move the additional types of material needed to handle the new requirements. If the quantity of the adjustment is small, the factory may also add it to its production schedule as currently planned. If it is a large adjustment it may be necessary for the factory to readjust or redraw its production schedule.

New customer lines and changes in design can be handled on an orderly basis by first determining when they will be made and then including them in our regular schedules. Sometimes it is necessary to introduce them gradually and taper off on the old lines. I have not attempted in this discussion to cover planning involved in carrying out the tooling job for new items since this work must necessarily precede production. However our production control is closely related to this activity because changes in product design and construction must be coordinated with the availability of equipment for production purposes.

Advantages of Production Control

By way of concluding comment, I would like to mention some of the advantages of production control as it applies to our business. Probably of first importance is customer service. By constantly building toward model inventories we are able to fill orders promptly on all standard sizes of product. During the war period it was necessary to operate on an allotment plan which to a certain extent simplified our production problem. Like many other manufacturers, our orders-holding position was very large, and our finished inventory very small.

Second in importance is the maintenance of balanced inventories of finished product. In a product that is perishable it is important to keep the length of time between production and sales to a minimum to avoid excess cost of keeping stock in condition and to minimize the cost of warehousing unbalanced, slow-moving stocks. A third factor is that of coordinated ordering of materials through a centralized plan. This plan operates to spread stocks evenly among our plants, based on production requirements. It tends to prevent overstocking of particular kinds and types of material and thus minimizes obsolescence and requires less warehouse facilities. A fourth consideration is that of orderly scheduling of production at each plant in order to secure maximum use of facilities and efficient operation both from the standpoint of achieving the desired production and keeping the number of equipment setup changes to the minimum.

Perhaps the desirability of effective production control can best be summarized by saying that it should enable a manufacturer to fill orders promptly with a product of good quality at the lowest possible cost.

A STANDARD HOUR WAGE INCENTIVE PLAN

by JOHN J. BARRANGER

Chief Factory Accountant and Divisional Auditor,
Bendix Radio Div., Baltimore, Md.

THE INCENTIVE PLAN outlined in this article was proposed with the objective of increasing the productivity of direct workers in a relatively small plant. No attempt was made to cover indirect workers or supervision or to extend the plan beyond the factory. It was necessary, at least temporarily, to retain some operations off the incentive basis and to permit of production workers, on occasion, being assigned to a nonincentive task. On the other hand, it was also intended to carry incentive to all practicable operations so that production workers would for the most part find themselves assigned to work on which they could put out for increased reward. The plan is based on a standard hour for each covered operation, alternatively expressed in standard number of good pieces per hour, and provides for official daily computation of incentive earnings.

Goals of the Plan

The plan looks toward achievement of the following results:

1. Reduction of unit labor cost on covered operations by approximately 25 per cent.
2. Increased production per man hour on the same facilities, eliminating a second shift or expenditure for added facilities.
3. Reduction in overhead applicable to product units by 19 per cent.
4. Increased earnings by shop employees of, on the average, 20 per cent (which would compute in this case to an increase of 18½ cents per hour or $7.40 per week).
5. Maintenance of shop worker's efficiency at a level between 120 and 125 per cent of standard performance as set by the plan.

The plan is of the simplest type, granted the proper setting of standards, which is always a difficult matter. It is intended that the employee shall know at all times where he stands. This means

principally information as to the standard production requirements of the job he is working on at any particular moment and sufficient understanding of the way the incentive works to calculate daily incentive earnings and to check them the following day (in this case) with the company calculation.

Earnings Provisions

An employee's base earnings are not affected by the plan. They remain subject to the existing job evaluation plan and his union's agreement with the company. If task standards are not earned each day the worker receives his base rate. The standards are stated in decimal standard hours per units produced and in number of pieces per hour and reflect 100 per cent performance at which the base rate is regarded as fully earned. For any production above these standards, an incentive amount is payable. Each day stands on its own feet in this regard and the failure to meet task on any one day will not affect payment of incentive earnings of a preceding or succeeding day. Each employee's efficiency is recorded each day in terms of the percentage of pieces over task to 100 per cent task and the excess over 100 per cent efficiency is the pay factor to be applied to the individual's base rate.

The standards established are based throughout on time studies which themselves must meet certain standards given a little later in this presentation. Apart from revisions resulting from changes in methods of operation, use of different materials, alteration in product designs, tooling, or equipment, the standard tasks as set are guaranteed as a condition of employment. The plan has no limiting provision as to the amount of incentive pay which an employee may earn and the absence of a limitation of this type avoids complications and serves as an evidence of good faith. It is, of course, not possible to eliminate a provision of this type unless the incentive plan is based on tasks which have been carefully engineered.

Efficiency Report

The plan provides for posting a Departmental Efficiency Report (Exhibit 1) each day in each department. This report indicates the name and clock number of each employee working on wage incentive standards in that department on the previous day. The report also indicates for each employee the actual hours worked (both on standard and on day work), the standard hours produced, the

Date: .....

Department: .....

DAILY DEPARTMENTAL EFFICIENCY REPORT

Employee's clock number	*Employee's name*	*Day work hours worked*	*Hours worked on standard*	*Standard hours produced*	*Total pay hours*	*Efficiency*

EXHIBIT 1

total pay hours, and the employee's percentage of efficiency. From the copy posted in the department each employee can calculate his previous day's earnings by simply multiplying by his base rate the figures in the "total pay hours" column opposite his name.

This report, prepared by the timekeeper-counters, is sent to the plant manager, to the plant superintendent, and to the appropriate foreman. The copies given to plant officials enable supervision to identify low producers and investigate the causes on a daily basis in an effort both to allocate responsibility and to rectify any conditions that are susceptible of improvement.

From its two uses, the daily efficiency report is at once a morale medium and a tool for trouble shooting and hits at excess costs from two directions. It has, of course, the disadvantages as well as the advantages of a public display. Individual employee performance becomes no secret. However, we are inclined to feel that it is an instrument to up-grade work all along the line and that few will find the posting of the report an objectionable feature.

Prescription for Time Studies

It is intended that the time studies on which task performance is based shall be beyond question and this is indeed the only warrant for giving the plan official confidence. As a consequence, the procedures governing the taking of time studies have been carefully set and codified under thirteen points, as follows:

1. Time studies will be taken only by a time study man or industrial engineer.
2. Each job to be studied will first be observed by the engineer for a reasonable period of time to determine what is happening. After that, the unit for payment will be determined and the operation will be broken down into its ele-

ments, with variables separated from constants and a *full* description of each element recorded on the time study form.

3. No less than ten readings will be taken for each element, with the exception of those few elements which occur only at rare intervals, in which case as many readings as feasible will be secured. If practicable, in all cases, and particularly in the case of major time standards, studies will be taken for several operators or if this is not possible, thirty or more cycles will be observed and recorded as performed by one operator.
4. The time values recorded will be "speed rated" for each element. In other words, the actual time taken by the operator may be increased or decreased depending on whether the operator was working faster or slower than "normal" (100 per cent). Thus, an operator who actually took one minute to perform an element of an operation and who was adjudged by the time study man to be working at a pace of 120 per cent would be allowed 1.2 minutes in the final standard for performing the element (plus, of course, other applicable allowances as indicated below).
5. The speed rated elemental time determined for each element of the operation will be weighted on an occurrence basis. For this purpose, if an element of the job occurs on the average only once every ten cycles, only 10 per cent of the time will be allowed in the final standard. All weightings will be determined by actual observation or sampling.
6. A fatigue allowance of not less than 5 per cent nor more than 15 per cent will be applied to all studies. The exact allowance to be used (within this range) in each individual case will be determined by the person taking the time study.
7. An allowance of 5 per cent for personal necessities will be included in each standard.
8. An allowance of 3 per cent to cover minor variations will also be included in each standard. If a greater allowance is needed the item will be set up as an element, speed rated, and weighted.

9. The final standard will be developed in terms of standard hours allowed per 100 units. The unit, of course, will be the item selected as the basis for the study. Also, the number of pieces per hour (for 100 per cent) will be calculated. Final figures will be carried out to two decimal places only.
10. Wherever possible, standard data will be developed to permit subsequent synthetic rate setting and to facilitate cost estimating.
11. Wherever possible, standards will be set on an individual employee rather than a group basis. However, where it is impracticable to allocate the final counts of units produced to an individual employee, the standard will be set on a group basis. Whether a standard shall be set on an individual or a group basis shall be determined by the person taking the time study.
12. All time studies shall be approved by the plant manager before being officially placed in effect.
13. When each time study has been completed and approved for a new or changed operation, the industrial engineer will make out a Master Rate Card (Exhibit 2) for that operation. This card contains the operation number, the operation's name, a brief description of the operation, the effective date, the standard hours allowed per 100 pieces produced, and the number of pieces per hour required for the operator to make 100 per cent. The master rate card

MASTER RATE CARD

Effective date: .....
Revised: .....
Revised: .....

Operation number: .....
Operation name: .....
Operation description: .....

..... Standard hours per 100 .....
(time) (unit)
.... per hour
(number) (unit)
Approved: ....
(Foreman) (Industrial Engineer)

EXHIBIT 2

is signed by the industrial engineer and approved by the foremen concerned. One copy is given to the foreman, one to the timekeeper, one to the payroll department, and one to the plant manager.

Principle of Control

To operate successfully and be trusted and trustworthy, from both management's and the employee's point of view, a wage incentive plan must operate under obvious control, attesting to accuracy and fairness. The original time studies must be correct and as jobs change in terms of methods, tools, equipment, material, or design, restudies must be promptly taken to determine what changes, if any, should be made in the original time standard. Both the setting of correct original rates and keeping rates adjusted and in line with shop changes is made the responsibility of the industrial engineer under the plan.

In addition, however, the wage incentive plan will never be properly controlled unless provisions are made for the accurate determination, on the scene of operations, of the significant performance factors. These include the length of time each operator works on wage incentive jobs and the number of satisfactory units of work produced by each operator during a stated time interval. To effect these controls the plan calls for a timekeeper-counter for each of the floors of the plant. These individuals as a group are placed under the supervision of the accounting department.

Incentive Plan Procedure in the Shop

At the beginning of each shift each employee starts work on the job to which he is assigned by his foreman. The timekeeper for the floor is required to contact each employee to see what job he is working on and to initiate a Job Time Card (Exhibit 3) in each case, writing in the starting time on the first job (all other time entries will be punched using a job time clock). The starting time must be either the starting time of the shift or the time punched by the employee on his daily time card, whichever is the later. The timekeeper also fills in the job time card as to date, shift, employee's name, employee's clock number, and the operation number, operation's name, and lot number. When the timekeeper has done this for all employee's he has, so to speak, rung them in on the incentive plan for the day.

As each employee finishes his job he goes to his foreman and is

JOB TIME CARD

Date: .....
Shift: .....

Operator's name:.....Operator's clock number:.....

Time (Start & stop)	*Operation number*	*Part number*	*Operation*	*Lot number*	*Total pieces*	*Rejected pieces*	*Good pieces*	*Standard hours allowed per 100 pieces*

EXHIBIT 3

reassigned. He then goes to the timekeeper and is punched out on the job just completed and punched in on the new job. This process is repeated for each job change during the day. When the employee is punched in on a new job, it is the timekeeper's duty to tell him the number of pieces per hour called for by the wage incentive standard if the job is covered by the plan, and to make the final count of units produced on the job just completed, and to enter it on the job time card. The timekeeper is charged with circulating about the floor in order to get and maintain an accurate count of the total number of units produced by each operator on each job worked on.

The basic data on the card is complete when the timekeeper has also entered the standard hours allowed per 100 pieces for each operation worked on by the individual and covered by the wage incentive plan. The cards for all employees are worked each morning from the data recorded during the previous day and the Daily Efficiency Report is prepared and posted for employee scrutiny.

Defective Work

The timekeepers have no responsibilty for defective pieces and do not operate as inspectors. The foremen are responsible for seeing that work of satisfactory quality is produced. If an operator is observed to be doing poor quality work, the foreman is required to point this out to him and that he will not get credit for the unsatisfactory pieces. The foreman fills out and signs a Rejected Work Slip (Exhibit 4) in these instances and gives one copy to the timekeeper and one copy to the employee. An employee is charged only for defective work within his control. The num-

REJECTED WORK SLIP

Date: .....

Operator's name: .....

Operator's clock number: .....

Operation name: ..... Operation number: .....

To timekeeper: Charge above employee with ..... pieces as they do not meet quality standards because .....

.....

Signed: .....
Foreman

EXHIBIT 4

ber of rejected pieces is recorded on the operator's job time card and the rejected work slip is stapled thereto for possible future reference.

What the Plan Does

It will be noted that, so far as its coverage extends, this plan is particularly thoroughgoing. Incentive is offered to employees in an unequivocal manner and the time study procedures are laid out to assure adherence to principles of measurement and freedom from bias in the establishment of task. The manner of recording incentive earned is prompt and public. The terms of the plan are free from complications which might render it difficult to understand. It is a stimulus to productivity and, as is appropriate, raises reasonable expectations of benefit in the minds of the management and the worker.

COMING ARTICLES

In the *N. A. C. A. Bulletin*, December 15, 1947

Achieving Control of Direct and Indirect Labor Costs
by Walter E. Anderson

Standard Costs Applied to the Manufacture of Silverware
by John F. Mickelson

An Order Cost System Under Budgetary Control
by J. C. Freeman

LIFO BASIS OF INVENTORY VALUATION AS APPLIED TO COTTON MILL INVENTORIES

by E. G. FIELD,
E. G. Field & Associates,
Atlanta, Ga.

THERE ARE a number of points in connection with the use of the so-called "lifo" basis of inventory valuation, when applied to cotton mill inventories—and hence to cotton mill costs also—which it is the purpose of this article to make. In general, these points reflect the fact that, with the fiscal year of many mills starting on October 1 as the cotton crop buying season is opening, a common practice is to build up inventories in the fall and let them decline through the year until they may again reach a low point at or near the following September 30 annual closing. If the lifo basis of inventory valuation is adopted by a mill, the starting quantity will be that applicable to the September 30 inventory for the year in question. The normal although not unexceptional course of quantity change will be; (1) increase during the buying season, (2) subsequent decreases which may even carry the inventory quantity below that of opening inventory, and (3) purchases prior to the close of the year in order to regain the opening quantity for valuation on the lifo basis, especially if replacement cost has risen during the year. On this picture then, the quantity increases or decreases between annual inventories are of a temporary character, and interim quarterly or monthly lifo inventory valuations made without consideration of this fact may not jibe with annual results or afford management guidance in solution of financial problems, which may include the question of dividends to be declared and other matters.

General Approach

In the explanations given in the paragraphs which follow, it is assumed that inventory records will continue to be maintained as formerly and that the lifo valuation basis will be achieved by the deduction of an appropriately computed reserve (inasmuch as to date, in spite of some price declines, "actual costs" generally stand well above lifo basis). It is not specified what type of actual cost should be used, whether first-in first-out, annual average, moving average, or other type, but the simplified examples given in the

exhibits have been drawn up to side-step these alternatives and attention is directed to setting off lifo valuation against any conventional inventory valuation which in general takes latest costs into inventory at the year end, which the lifo basis does not. The terms "actual costs," "cost" and "conventional cost" are used for convenience to indicate a cost basis of pricing inventory other than lifo.

Lifo, abbreviated from the words "last in, first out," is a descriptive term applying to an inventory that has been valued through the use of the principle, on an annual basis, that the last purchases of the period were the first to go out in sales. This type of inventory valuation came into cotton mill practice with the Internal Revenue Act of 1939, which first permitted its application in the computation of Federal income taxes. It provides a method to figure taxes on incomes that have not been affected by what some regard as "unrealized profits," i.e., increase of inventory values, through the replacement of normal inventory quantities by purchases at higher costs. From experiences following earlier inflationary periods, provision was made in this way to permit cotton mills and other industries to hold their basic inventory quantities at original base period unit valuation.

While cotton prices were advancing, every one on the lifo inventory plan seemed to be satisfied because profits continued good and taxes were minimized. Mill management was content with the continued low valuation of inventory at less than the current market price. More experience in the use of lifo inventories, especially in declining markets, has raised some questions concerning the interpretation of results. There are some significant things to be learned about the use of lifo inventories. In this presentation, discussion will be directed to the more important features:

1. Use of lifo price reserves and recognition of what are designated as "accrued losses" in interim decreases of lifo inventory quantities, so as to determine the earnings in each period.
2. Relationship of the economic fact of current replacement costs to the lifo data developed for Federal income tax returns and financial statements.

Substance of Lifo Method

The method to be used in determining the value of the basic or first inventory is described in the Income Tax Regulations and is

generally known, so will not be repeated here. So long as the quantity remains constant, the lifo value of the inventory will not change, except as to change in manufacturing cost added to the commodity cost. At the close of the fiscal year, if the quantity has decreased, then the original lifo unit cost will be applied to the quantity remaining and so establish a new lifo value of the inventory. On the other hand, if the quantity in the closing inventory is more than at the start of that fiscal year, then the first purchases in that year may be used to cost the increased quantity and added to the original lifo value to establish the new lifo value of the inventory at the close of the year.

When closing inventories have increased for several years, the valuation becomes interesting in that any portion of the original starting quantity is continued at the average cost therefor, with the increases in quantity separately valued in the respective years. Thus, the closing inventory is built up in layers on the original basic inventory remaining. When the closing inventory decreases, then the quantities with corresponding prices must be taken down in reverse order to the way in which the increases had been built up. Decrease in the original lifo inventory will be at the average price, in accordance with Regulations 111, Sec. 29.22(d)2(3):

> "Goods of the specified type included in the opening inventory of the taxable year for which the method is first used shall be considered as having been acquired at the same time and at a unit cost equal to the actual cost of the aggregate divided by the numbers of units on hand."

Some analyzers of cotton mill profits have given to the management misleading information as to the effect of price and quantity changes, especially in the interim periods, when the lifo basis of inventory valuation is used. To assist in examining what takes place, some simple hypothetical illustrations are submitted in the course of this article.

Use of Price Reserves

The use of a price reserve to bridge the gap from actual to lifo inventory valuations, although merely a technique, is often a source of misunderstanding at interim dates. This is because the accountant, knowing that management expects to come out with the same inventory quantity at the end of the year as at the beginning, leaves the reserve unchanged meanwhile.

In general, the pricing of inventories at both actual cost and lifo will be expected to agree only at the time of the original lifo application. In subsequent periods it is to be expected that the actual cost of the closing inventory will be more or less than the starting lifo value. In Exhibit 1 the period ending September 30, 1944, shows a lifo inventory at 10 cents a pound at the date of adoption of the basis and coinciding with actual cost. The quantities and prices have been kept simple to facilitate observing the effect of the changes that will be shown. At the following annual closing, the previous quantity is inventoried again but this time the material has cost 14 cents on the former basis of pricing on which the detail records are maintained and which we are calling "cost" or "actual" throughout this presentation. Accordingly, a price reserve of 4 cents a pound has been applied to reduce the value from cost to the lifo value shown on the financial books.

The first element of distortion in the earnings picture which may creep in at interim date is the maintenance of this reserve unchanged. Exhibit 1 shows what will happen if this reserve is held constant and the quantity goes up or down. Using an unchanged reserve, it will be impossible, in amounts which are important proportionately, to reconcile back to the opening lifo inventory by deducting the reserve from the inventory at cost. The illustration of quantity increase shows the inventory at cost at the same price as at the beginning of the period but the quantity increase has caused inclusion in lifo inventory of a purchase early in the period when the price had gone to 11 cents, calling for additional reserve. The illustration of quantity decrease naturally discloses that the stationary reserve figure has become too high. These two examples should be sufficient to show that a constant price reserve can produce results that are definitely misleading for interim periods with varying quantities, even when the unit cost of acquisition of quantities in inventory on the former pricing basis remains constant.

The alternative is to maintain a reserve representing, for each pound of cotton in the inventory, the difference between the unit value on the actual cost basis and the average lifo price. Lifo inventories are seldom stated in average unit cost, for obvious reasons, but for this purpose it helps. When the inventory quantity is increased or decreased, the lifo average is maintained through adjusting the price reserve. This condition is shown in the final section of Exhibit 1.

USE OF PRICE RESERVES FOR LIFO INVENTORY VALUATION

Closing date	Particulars	Inventory Pounds	Average	Value	
Sept. 30, 1944	LIFO and cost Previous..	1,000	10.00¢	$100.00	
Sept. 30, 1945	Cost	1,000	14.00	140.00	
	Reserve	—	4.00*	40.00*	
	LIFO Present	1,000	10.00¢	$100.00	
With Price Reserve Constant, and					
Pounds increased					
	Cost	1,200	14.00¢	$168.00	
	Reserve	—	3.33*	40.00*	
	LIFO Present	1,200	10.67¢	$128.00	
	Increase	200	11.00	22.00	
	Previous	1,000	10.60¢	$106.00	Wrong
Pounds decreased					
	Cost	400	14.00	56.00	
	Reserve	—	10.00*	40.00*	
	LIFO Present	400	4.00¢	$ 16.00	
	Decrease	600	10.00	60.00	
	Previous	1,000	7.60	76.00	Wrong
With Lifo Average Constant, and					
Pounds increased					
	Cost	1,200	14.00	168.00	
	Reserve	—	3.83*	46.00*	
	LIFO Present	1,200	10.17¢	$122.00	
	Increase	200	11.00	22.00	
	Previous	1,000	10.00	100.00	
Pounds decreased					
	Cost	400	14.00	56.00	
	Reserve	—	4.00*	16.00*	
	LIFO Present	400	10.00¢	$ 40.00	
	Decrease	600	10.00	60.00	
	Previous	1,000	10.00¢	$100.00	

*Designates negative amount, usually shown in red.

EXHIBIT 1

Additional Questions

Some accountants may think that by this device the corresponding interim inventories and profits have been properly stated. However, when the original lifo inventory value is temporarily reduced through lower quantity, the effect of its ultimate replacement will have been omitted from consideration. The effect should be included in the operating statement for the current interim period, for, from both management and tax viewpoints, a month or a quarter is simply a progressive segment of the year as a whole. In addition to the effect of a decrease in the quantity of inventory, there must also be considered the effect of market price changes as applied to the cotton received during the period. And finally, after finding how to handle the interim statements, some consideration can be given to the year as a whole.

"Accrued Loss" in Decreases of Quantity

Perhaps the principal concept which it is necessary to get across to expose the error, from an annual viewpoint, which may exist in quarterly statements on the lifo basis, even when the price reserve is computed as has been recommended, is the idea of the existence of an "accrued loss" when the quantity on hand at the close of the interim period is less than the lifo base quantity. That this *is* a loss is based on the inventory acquisition and use cycle described and upon the assumption that before the end of the fiscal year the management will wish to restore any impairment of lifo initial quantity so as not to lose any of the advantage of lifo initial price. If this is so, none of the lower costs represented by the original lifo inventory are to be charged to cost of sales in the year as a whole and if they are so charged in the statement for any one quarter, instead of the replacement costs which will ultimately be charged, the statement for the quarter shows a higher profit than will finally be attributable to it as a segment of the full year.

To account for this element at each quarter end, if there has been a quantity decline below the original lifo quantity, an additional entry, besides the charge or credit for price reserve adjustment, is made charging cost of sales. The amount of this charge will be the quantity impairment of original lifo inventory times the unit difference between inventory at conventional cost and average lifo inventory unit price. The result is a cost of sales on lifo basis but as if original lifo quantity were not depleted, in spite of the temporary existence of this situation.

The amounts of $12 and $42 on Exhibit 2 in the appropriate column represent correction to interim statements for this loss element. The hypothetical figures used in the exhibit may be observed to continue the illustrative quantities and amounts used to start of Exhibit 1, and carry them through a series of changes representing two annual periods and four quarterly ones making up the second year which is shown in detail.

Adjusting Quarterly Statements

In the first quarter, the quantity received (1700) was in excess of the quantity used (1500), so the inventory has been increased (1200 from 1000). The cotton received was also at a higher price. To maintain the lifo average price for this interim inventory, the price reserve has been increased (now to $52) for the actual inventory quantity. Since the management intends to return to the starting lifo inventory quantity, the temporary excess quantity has already been marked down to the present lifo average by applying the reserves, and no additional loss need be accrued. The price reserve of $52 is now $12 higher than at the start of the year and the cost of sales has been correspondingly increased so that the interim profits will not be overstated.

In the second quarter, the quantity received (1100) is shown as having been less than the quantity used (1500) so the inventory quantity has been decreased (800 from 1200). The cotton received was also at a higher price. To maintain the lifo average price for this interim inventory, the price reserve has been decreased (now to $48) for the actual quantity. Since the management intends to return to the starting lifo inventory quantity, the temporary shortage in lifo quantity at higher prices must be considered, and this has been here computed as an accrued loss of $12. In this particular instance, the accrued loss when added to the price reserve gives a total adjustment of $60 that is $8 more than previously provided so adjustment of the larger amount is made to the cost of sales in order that the interim profits be not overstated.

The third quarter continues the inventory decrease (400 from 800) while the cotton received was at still higher prices. To maintain the lifo average price for the interim inventory, the price reserve has been further decreased (now to $28) for the actual inventory quantity. Since the management intends to return to the lifo inventory quantity at the start of the fiscal year, the temporary shortage in lifo quantity at higher prices must again be

ADJUSTMENT OF COST OF SALES TO APPLY LIFO PRICE RESERVE AND ACCRUED LOSS AT INTERIM DATES, RESULTING FROM QUANTITY DECREASES

Particulars	Inventory and changes			Change in price reserve	Accrued loss and (reversal)	Cost of sales and adjustment
	Pounds	Average	Value			
Sept. 30, 1944						
LIFO	1,000	10.00¢	$ 100.00			
Sept. 30, 1945						
At Close	1,000	14.00	140.00			
Reserve	—	4.00*	40.00*	$40.00*		
LIFO	1,000	10.00	$ 100.00			
Dec. 31, 1945						
At Start	1,000	14.00	140.00			
Received	1,700	15.00	255.00			
Available	2,700	14.63	395.00			
Used	1,500*	14.33*	215.00*			$ 215.00
At Close	1,200	15.00	180.00			
Reserve	—	4.33*	52.00*	12.00*		12.00
LIFO	1,200	10.67¢	$ 128.00			$ 227.00
Mar. 31, 1946						
At Start	1,200	15.00	180.00			
Received	1,100	16.00	176.00			
Available	2,300	15.48	356.00			
Used	1,500*	15.20*	228.00*			228.00
At Close	800	16.00	128.00			
Reserve	—	6.00*	48.00*	4.00	$12.00*	8.00
LIFO	800	10.00¢	$ 80.00			$ 236.00
June 30, 1946						
At Start	800	16.00	128.00			
Received	1,100	17.00	187.00			
Available	1,900	16.58	315.00			
Used	1,500*	16.47*	247.00*			247.00
At Close	400	17.00	68.00			
Reserve	—	7.00*	28.00*	20.00	{$42.00* ((12.00)	10.00
LIFO	400	10.00¢	$ 40.00			257.00

Sept. 29, 1946						
At Start	400	17.00	68.00			
Received	2,100	19.00	399.00			
Available	2,500	18.68	467.00			
Used	1,500*	18.47*	277.00*			277.00
At Close	1,000	19.00	190.00			
Reserve	—	9.00*	90.00*	62.00*	(42.00)	20.00
LIFO	1,000	10.00¢	$ 100.00			$ 297.00
Sept. 30, 1946						
At Start	1,000	14.00	140.00			
Received	6,000	16.95	1,017.00			
Available	7,000	16.53	1,157.00			
Used	6,000*	16.12*	967.00*			967.00
At Close	1,000	19.00	190.00			
Reserve	—	9.00*	90.00*	50.00*		50.00
LIFO	1,000	10.00¢	$ 100.00			$1,017.00

Note: * Designates negative amount, usually shown in red.

EXHIBIT 2

considered, and this has been computed as an accrued loss of $42. When this accrued loss is added to the price reserve, the total adjustment of $70 is $10 more than at the close of the previous interim, and therefore the cost of sales is correspondingly increased for this quarter also in order that the interim profits will not be overstated.

In the fourth quarter, the management has accomplished its intention to acquire sufficient cotton to restore the starting lifo inventory quantity. Because of further increase in price of the cotton received, it is now necessary also to increase the price reserve to $90. Since there was no longer any decrease in lifo quantity, the previous accrued loss has been eliminated. The total adjustment of $90 is $20 more than at the close of the previous quarter, so that cost of sales must be correspondingly increased by that amount in order that the profits will be properly stated.

The results for the year are finally shown and will be found to agree with the totals of the interim four quarters that have been presented above. Moreover, the treatment of the respective quarters was identical with that for the year as a whole and the interim procedure is consistent. The procedure is practical and the results are reasonable. The additional feature of the accrued loss in lifo

inventory quantity will at times necessitate another item being included among the liabilities shown in the balance sheet at some interim periods. At the close of the year, such an accrual should disappear as the change in lifo inventory quantity will have been accepted by the management.

Detailed Methods May Be Varied

The quantities, prices, and situations used in Exhibit 2 were selected for purposes of simplicity in illustration. Particular mills, considering in detail their own practices, will want to adopt or continue methods which are simplest from an operating viewpoint in getting from conventional cost basis of inventory to lifo basis and taking account of the elements to which attention has been called.

Also, in determining the "accrued loss" in the illustrations given in Exhibit 2, the average price per pound therefor was the same as that applying to the price reserve. This assumes that the loss in lifo inventory quantity could have been overcome at the average price of the cotton received. In actual practice, it may be preferable to determine the accrued loss by deducting the lifo value from the expected procurement cost, using prices taken from reference to the open purchase orders that were: (1) past due for delivery to the mill, (2) still due for future delivery at fixed prices, or (3) obtainable at current market. Such a procedure will look further into the future than the illustrated method to ascertain what the replacement costs, which measure the "accrued loss," will actually be.

Effect of Providing For Accrued Loss

In reflecting on the differences between conventional cost and lifo bases, it may help to take the adjustments to cost of sales as shown in Exhibit 2 and state them, for the same periods, as percentages of actual cost of sales before adjustment. This is done in Exhibit 3.

In this instance the final effect of the lifo plan at the close of the fiscal year was to increase the cost of sales by $50, which is 5.17 per cent of the developed cost from the cotton used at cost. However, it is noticeable that in the fourth quarter the increase in price paid for the cotton resulted in an increase of $62 in the price reserve, which was 22.38 per cent increase in the actual cost of sales. This was partially offset by the $42 that had been pre-

RATIO ANALYSIS OF ADJUSTMENT TO COST OF SALES

	Adjustment to cost of sales			*Cost of sales*		
	Price reserve	*Accrued loss*	*Total adjustment*	*Used at cost*	*Adjusted to Lifo*	*Omitting accrued loss*
Quarter ended:						
Dec. 31, 1945	$12.00	—	$12.00	$215.00	$ 227.00	
Mar. 31, 1946	4.00*	12.00	8.00	228.00	236.00	
	8.00	12.00	20.00	443.00	463.00	
June 30, 1946	20.00*	30.00	10.00	247.00	257.00	
	12.00*	42.00	30.00	690.00	720.00	
Sept. 30, 1946	62.00	42.00*	20.00	277.00	297.00	
Year end Sept. 30, 1946	$50.00	—	50.00	$967.00	1,017.00	
Quarter ended:						
Dec. 31, 1945	% 5.58	—	5.58	%100.00	105.58	%105.58
Mar. 31, 1946	1.75*	5.26	3.51	100.00	103.51	98.25
	1.80	2.71	4.51	100.00	104.51	101.80
June 30, 1946	8.10*	12.15	4.05	100.00	104.05	91.90
	1.74*	6.09	4.35	100.00	104.35	98.26
Sept. 30, 1946	22.38	15.16*	7.22	100.00	107.22	122.38
Year ended Sept. 30, 1946	% 5.17	—	5.17	%100.00	105.17	%105.17

Note: *Designates negative amount, usually shown in red.

EXHIBIT 3

viously accrued as the loss in lifo inventory quantity, the effect of which had been already included in the adjusted cost of sales, and was 15.16 per cent of actual or conventional cost of sales. Because of this foresight in acknowledging the accrued loss in change of lifo inventory quantity, the net effect in the final quarter was to include only $20 additional total adjustment, which was 7.22 per cent of the actual cost of sales.

It is noticeable that had this advance provision for the accrued loss in lifo inventory quantity been omitted from consideration, then in the second and third quarters the adjusted cost of sales would have been 1.75 per cent and 8.10 per cent below the actual cost of sales, and thus would have resulted in abnormally high closing adjustments being necessary in the final quarter to cor-

rect the cost of sales to the closing adjusted figure necessary. This illustrates how, on a rising market, any use of adjusted cost of sales below the actual cost is due to the sale of lifo inventory quantity and, if a temporary condition, the profit has been increased for the moment to an extent that may be misleading.

In the percentages of cost of sales shown in Exhibit 3, it may be observed that the quarterly results would have been in error by about 30 per cent, from a negative adjustment of 8.10 per cent to an additional adjustment of 22.38 per cent, had the accrued loss of lifo inventory quantity been omitted from consideration. By making provision for the accrued loss in the interim periods, the adjustment to the cost of sales was between 3.51 per cent and 7.22 per cent added in the respective quarters. In this instance, during the last quarter a possible variation of 22 per cent in the cost of sales was reduced to about 7 per cent adjustment through the earlier consideration of the accrued loss in lifo inventory quantity.

When Market Declines

In the case illustrated in Exhibit 3, the cotton price had been increasing each quarter and jumped in the final quarter. The effect of the lifo inventory plan in the fiscal year was to decrease the profit by the five per cent that was added to the actual cost of sales as an adjustment. In a declining market the opposite effect will be observed. At such time, the sales prices must not be decreased to correspond to the decrease in cost of sales for the adjustment brought about by the lifo inventory plan, which is intended to affect profits for Federal income tax and reporting purposes and should not be used in computing costs for selling purposes. Quotation costs should be kept on replacement costs regardless of lifo.

Formula for Adjustment

The adjustments necessary to be made to inventory values shown on detailed cost records to provide figures for the lifo basis in such a way as not to carry quarterly statements away from a realistic presentation of operating results as an integral part of the full year, have been traced through a single set of illustrative figures developed in the accompanying exhibits. If reduction to formula is desired, it may be said that to determine what has been the effect of the inventory plan at any time in the fiscal year, the

extent of the increase or decrease in the cost of sales can be readily determined by subtracting (1) the increase in lifo value of the opening and closing inventories, from (2) the increase in actual cost of those same inventories, to arrive at (3) the increase in price reserve, and then adding (4) the increase in accrued loss attending those inventories.

Crop Year as Fiscal Year

Cotton mills with fiscal years coinciding with the cotton crop year, i.e., September 30 closings, will have much less difficulty with the lifo inventory method since their annual closings will occur when their inventories are at the lowest quantity. On the other hand, cotton mills with fiscal years ending during the late fall months or mid-winter, when their inventories are at highest quantities, will be subject to the larger effect of price changes upon profits and also will be bothered during the year by a hidden loss factor of undetermined amount unless what we have designated as "accrued loss" in lifo inventory quantity declines also has been considered in all interim statements. Thus, cotton mills using the lifo inventory method may find it desirable to move their fiscal years to coincide with the cotton crop years.

Regardless of fiscal closing date, any month or quarter in the fall of the year, when the inventory has increased in quantity, will show a proportionately lower profit than would be developed from the actual cost alone. In other periods, when inventories decline, the profits will be higher than realistic, based on return to starting quantity before the close of the year, unless adequate provision has been made for any accrued loss attending inventories lower than the starting lifo quantities.

Conclusion

Many cost accountants and engineers have already had some interesting experiences in determining interim profits while using the lifo plan. The explanations and the illustrations given are intended as a contribution toward the subject of what takes place when cotton mill inventories are placed on a lifo basis. It may also serve as a pointer to some of the difficulties of application, especially in providing mill management with useful information.